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TRANSLATION
From **German into English**

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On this day personally appeared before me
who, after being duly sworn, deposes and states: Elisabeth A. Lucas

That he is a translator of the **German** and English languages by profession and as such connected with the **LAWYERS' & MERCHANTS' TRANSLATION BUREAU;**

That he is thoroughly conversant with these languages;

That he has carefully made the attached translation from the original document written in the **German** language; and

That the attached translation is a true and correct English version of such original, to the best of his knowledge and belief.

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JUL 17 2006

Susan Tapley

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Commission Expires July 27, 2006

Reference is made to the following documents:

D1:	US-A-3 828 622	D2:	DE 17 52 432 A1
D3:	US-A-4 305 307	D4:	US-A-4 550 626
D5:	US-A-3 585 875	D6:	US-A-4 130 024
D7:	US-A-3 439 554	D8:	EP-A-0552835

There are two independent claims: 1 and 14 in the application. Claim 1 is a device while claim 14 is a method which refers to the device in claim 1.

1. 1 Novelty of independent claim 1

D8, which is considered the closest prior art, shows and describes a (the references between parentheses apply to this document)

> Drive (1), with at least one motor element (3) which is mounted on or in a retaining element (27) (figures 1 and 2), the motor element driving, directly or indirectly, if appropriate, via an integrated gear mechanism (directly in figure 1), a pinion (7) which interacts with a gearwheel guide (9), with, in order to ensure permanent freedom from play and/or permanent tooth-to-tooth contact between pinion and gearwheel guide, after a force determination by means of force sensors in the horizontal and/or vertical direction of the pinion (column 2, line 35 – column 3, line 4), the retaining element can be controlled, can be moved or can be prestressed (column 2, line 51 – column 3, line 4) in relation to a receiving element (15) in an actively activatable manner during operation via at least one actuator (21), with the selectable prestressing force on the pinion being adapted or changeable correspondingly during operation as a function of load and/or acceleration and/or speed (as a function of load in D8, column 2, line 51 - column 3, line 4).

Therefore, the subject matter of claim 1 differs from the drive known from D8 in that the drive is a linear drive, in particular rack and pinion drive, with the one gearwheel guide being a linear guide.

However, these features are implicitly also contained in D8.

The problem addressed by the application is: in order to increase the machine accuracy, to keep the play occurring due to installation or wear between the meshing teeth under control during operation in a simple, effective and cost-effective manner, even under changing loads (description, page 2, lines 4-14 and page 5, lines 1-12).

The same problem is also solved in D8 (column 1, line 11 - column 2, line 34), between two gearwheels.

The problem of play between intermeshing teeth is generally known in the art, irrespective of the embodiment of the toothed elements. Therefore, the occurrence of this problem between a gearwheel and a rack of a linear drive is not novel.

In addition, a rack, as is known, is a special case of a gearwheel, with the diameter of the gearwheel being infinite. It is therefore apparent that all of the features of claim 1 are known explicitly or implicitly from D8 and hence the subject matter of claim 1 is not novel (PCT Article 33(2)), or is at least not inventive.

1.2 Industrial applicability

The subject matter of claim 1 appears to meet the requirements of PCT Article 33(4), since it appears to be producible and also usable at least in the field of gear mechanism technology.

1.3 Dependent claims 2-14

Dependent claims 2-13, which relate to further embodiments on the invention according to claim 1, likewise do not meet the PCT requirements, since the meeting thereof presupposes the same of the claim on which they depend; in addition, the features of the claims listed below appear to be known, at least as seen on their own, from the documents mentioned in this respect; therefore, they do not comprise any essential features which could justify the novelty or an inventive step in any way:

- claims 2-6:	known from D8 (figures 1 and 2);
- claim 7:	known embodiments of an actuator;
- claims 8-11:	known in control technology;
- claims 12 and 13:	known in machine tool manufacturing.

11.1 Novelty of independent claim 14

The method in claim 14 refers to claim 1 which is however not considered novel. Accordingly, the subject matter of claim 14 does not appear to be novel either, or at least not to be inventive.

11.2 Industrial applicability

The subject matter of claim 14 appears to meet the requirements of PCT Article 33(4), since it can be produced and can also be used at least in the field of gear mechanism technology.

11.3 Dependent claims 15-17

Dependent claims 15-17, which relate to further method steps of the invention according to claim 15, likewise do not meet the PCT requirements, since the meeting thereof presupposes the same of the claim on which they depend; in addition, the features of the claims listed below appear to be known, at least as seen on their own, from the documents mentioned in this respect; therefore, they do not comprise any essential features which could justify the novelty or an inventive step in any way:

- claims 15-17: known in control technology.

...a slight degree of play, in particular a backlash, pinion and linear guide should have tooth profiles.

A disadvantage of this is that, in the case of the conventional linear drives or rack and pinion drives with a pinion and rack, machine accuracy and machine dynamics are considerably reduced, since, for example, degrees of stiffness of the gear mechanism fluctuate. In addition, the tooth profiles of pinion and linear guide are subject to a certain degree of wear, which likewise causes play. In particular, the high degree of wear and the inaccuracy are caused by the mechanically hard prestressing of the gear mechanism, as a result of which very large gear mechanisms have to be used.

In this case, a prestressing force on the pinion is no way constant, since, for example, at, for example, different loads, speeds and also accelerations and inaccuracies in the linear guide, a different degree of wear is caused or is provided from the outset due to manufacturing inaccuracies.

Furthermore, inaccuracies of the linear guide as a consequence of, for example, thermal expansion are not compensated, with a different degree of wear being caused on linear guide and pinion. Nowadays, however, a higher degree

of accuracy of a linear drive, which is moved in relation to a linear guide, or a linear guide which is moved in relation to the fixed linear drive, is required. This cannot be ensured with the conventional linear drives.

Linear drives of this type can be used, for example, in all machine tools, laser machines, milling cutter machines, woodworking lasers or the like.

US 3,828,622 discloses a machine tool, in which a machine table can be moved to and fro in relation to a rack by means of a driven pinion. In this case, the rack is pressed against the pinion by means of a roller via a lever which is spring-loaded.

DE 17 52 432 A describes a device for eliminating play in the gear mechanism of pipe-bending machines, in which device two shafts can be displaced with respect to each other in a purely mechanical manner via elongated holes.

US 4,305,307 discloses that play between two gear wheels on a rack can be compensated for by a torsion spring.

The disclosures of US 4,550,626, US 3,585,875, US 4,130,024, US 3,439,554 each show linear drives, with compensation of the play taking place purely mechanically via spring elements.

EP 0 552 835 B1 describes a gear mechanism with changeable mechanical prestressing. In order to change a mechanical prestressing, the prestressing force is changed there as a function of a motor current signal. In this case,

the current, which flows through a coil by the prestressing force being influenced, is controlled as a function of the motor current.

Patent Claims

1. A linear drive, in particular rack and pinion drive, with at least one motor element (2) which is mounted on or in a retaining element (1.1, 1.2), the motor element (2) driving, directly or indirectly, if appropriate via an integrated gear mechanism (3), a pinion (4) which interacts with a linear guide (5), characterized in that, in order to ensure a permanent freedom from play and/or permanent tooth-to-tooth contact between pinion (4) and linear guide (5), in a force determination by means of force sensors in the horizontal and/or vertical direction of the pinion (4), the retaining element (1.1, 1.2) can be controlled, can be moved or can be prestressed in relation to a receiving element (6) in an actively activatable manner during operation via at least one actuator (12.1 to 12.3), with the selectable prestressing force on the pinion being adapted or changeable correspondingly during operation as a function of load and/or acceleration and/or speed.

2. The linear drive as claimed in claim 1, characterized in that the retaining element (1.1, 1.2) is coupled in a manner such that it can move to and fro linearly in relation to the receiving element (6) via at least one guide element (11).

3. The linear drive as claimed in claim 2, characterized in that the guide element (11) is designed as a leaf spring

element (10), linear guide, needle roller bearing or the like.

4. The linear drive as claimed in at least one of claims 1 to 3, characterized in that the retaining element (1.1, 1.2) is spaced apart slightly from the receiving element (6) and said elements are arranged parallel to each other.

5. The linear drive as claimed in claim 3 or 4, characterized in that receiving element (6) and retaining element (1) are connected to each other by means of respective leaf spring elements (10) in flange regions in each case in lateral regions in the region of an upper side (8) and in the region of a lower side (9) of retaining element (1.1) and receiving element (6).

6. The linear drive as claimed in at least one of claims 1 to 5, characterized in that, in one or both lateral regions in the receiving element (6), a connecting piece (13) at least partially engages in a recess (15) of the retaining element (1.1), and the at least one actuator (12.1, 12.2) is inserted between a flange of the retaining element (1.1) and the connecting piece (13).

7. The linear drive as claimed in at least one of claims 1 to 6, characterized in that the actuator (12.1, 12.2) is designed as a piezoactuator, shape memory actuator, or electrically mechanically or hydraulically operated actuator.

8. The linear drive as claimed in at least one of claims 3 to 7, characterized in that the at least one guide element

(11) is assigned at least one force and/or displacement sensor (16).

9. The linear drive as claimed in at least one of claims 1 to 8, characterized in that the actuator (12.1 to 12.3) is assigned at least one force and/or displacement sensor (16).

10. The linear drive as claimed in at least one of claims 6 to 9, characterized in that the connecting piece (13) is assigned at least one force and/or displacement sensor (16), in particular in the region in which it receives the actuator (12.1, 12.2).

11. The linear drive as claimed in at least one of claims 1 to 10, characterized in that the motor element (2) and/or gear mechanism (3) is assigned at least one force and/or displacement sensor (16).

12. The linear drive as claimed in at least one of claims 1 to 5, characterized in that an actuator (12.3) as a spindle drive (17) for the linear movement of a wedge (18) sits on the retaining element (1.2) in the region of an upper side (8).

13. The linear drive as claimed in claim 12, characterized in that the receiving element (6) is assigned a flange (19) which interacts with the wedge (18) of the spindle drive (17) of the retaining element (1.2).

14. A method for operating a linear drive (R_1, R_2), in particular rack and pinion drive, in which a motor element (2), which is mounted on or in a retaining element (1.1, 1.2)

and drives a pinion (4), if appropriate via an integrated gear mechanism (3), interacts with a linear guide (5), characterized in that, by means of a force determination of the pinion (4) in relation to the linear guide (5) in the horizontal and/or vertical direction by means of force sensors to ensure permanent freedom from play and/or permanent tooth-to-tooth contact between pinion (4) and linear guide (5), a prestressing force of the pinion (4) in relation to the linear guide (5) is determined and/or set, with the selectable prestressing force on the pinion being adapted or changed correspondingly during operation as a function of load and/or acceleration and/or speed.

15. The method as claimed in claim 14, characterized in that, during operation, with changing accelerations and/or speeds and/or loads and/or dead weights, a prestressing force between pinion (4) and linear guide (5) is determined and/or changed and/or regulated by means of permanent measurement of the force in the horizontal and/or vertical direction for the activation of the actuators (12.1, 12.2).

16. The method as claimed in claim 14 or 15, characterized in that the prestressing force between pinion (4) and linear guide (5) is controlled during operation as a function of acceleration in order to ensure permanent freedom from play and/or permanent tooth-to-tooth contact between pinion (4) and linear guide (5).

17. The method as claimed in at least one of claims 14 to 16, characterized in that a prestressing force is set permanently via the at least one actuator (12.1 to 12.3) via the guide elements (11), in particular the leaf spring elements (10), and the prestressing force is permanently changed and/or adapted during operation with changing accelerations and/or loads and/or speeds.